

Further anent "frost flowers"

An explanation of frost crystals on dried plant stems

H. M. JENNISON

In Mr. Raymond H. Torrey's article published in *TORREYA*, for Jan.-Feb., 1931, we found a very interesting and accurate account of a phenomenon not uncommonly observed in the vicinity of Knoxville, Tennessee. At least six of my colleagues and students have seen and speculated on the formation of similar ice ribbons. With us, such ice ribbons have been observed on the lower internodes of the main stem of such coarse herbs as *Verbesina occidentalis*, *V. virginica*, and *Pluchea petiolata*. Mr. Torrey concludes with the intriguing question, "Can anyone offer an explanation as to the mechanics of this phenomenon?"

The following explanation of the phenomenon in question has developed as a result of the observations made at times during the past three years. No opportunity has been available for experiments, and I do not suppose that this offering can withstand the critical gaze of a physico-mechanical engineer. Perhaps, however, it may be sufficiently reasonable to satisfy the average naturalist-observer.

In the first place, it is important to note that phenomena similar to the one described by Mr. Torrey, as seen by us, occur during the late fall and mid-winter months. By that time successive frosts have defoliated the vegetation and cut down the tender twigs. When and wherever we have found these fantastic ice-crystal ribbons they were of considerable size and occurred near the base of the stem. We have observed them in actual process of development. With few exceptions the phenomena have been noted early in the day, or if later, only on north slopes where the plants were shaded until late in the afternoon. Up to the dates of observation, the temperature had not been low enough to cut down the stout stems of such coarse herbs as those named above, much less kill the roots. Nor was the ground frozen. In fact, except in the surface layers the soil was moist and warm enough for biological activity. Under the existing environmental conditions, the root systems of these plants were still functioning quite vigorously and a considerable "root-

pressure" was forcing water through the larger branches of the root and up the stems. No leaves, and few if any living cells, remained above ground to utilize the water being carried up in the essentially uninjured vessels of the outermost layers of the xylem. The ascending stream of considerable volume was rather quickly chilled and the water frozen soon after it reached a point in the stem slightly above ground. The water, upon being frozen, expanded and ruptured the cortical tissues appearing as the beginning of a short ribbon of ice. The first-formed ice is forced on by the transpiration stream, which freezes as it comes to the surface and is exposed to sub-freezing temperatures.

The ice masses are thin, fragile, and quite flexible, so that extensive ribbons or bands, result. We have observed three-inch wide ice ribbon bands developing to become four or five inches long. Also, I have observed that the ribbons were faintly corrugated and take this as an indication of the fact that the water was frozen and was crystallized somewhat before it had emerged from the tissues of the stem.

UNIVERSITY OF TENNESSEE
KNOXVILLE, TENNESSEE.

"Frost flowers" in Florida

ROLAND M. HARPER

Mr. Raymond H. Torrey's note on frost crystals on *Cunila* in northern New Jersey, in the Jan.-Feb. number of TORREYA, reminds me of a similar phenomenon that I observed on the same day about eleven degrees farther south. On the morning of Nov. 27, 1930 (Thanksgiving Day), I went with Dr. John K. Small and Dr. Herman Kurz to Wakulla County, Florida, to show Dr. Small a certain plant he was looking for. In Tallahassee, 18 miles north of the locality to be cited, the weather had been cloudy and rainy most of the month (much more than usual for November), but that day was clear, and there had been a killing frost the night before.

In flat pine woods underlaid by limestone, in the Gulf Hammock region, about half way between Wakulla and St. Mark's, we noticed around a cypress pond, on many dead stems of *Pluchea foetida* (formerly known as *P. bifrons*), a few inches from the ground, delicate excrescences of ice almost exactly like that figured by Mr. Torrey; something that none of us had ever seen